

ITS
DIGITAL DATA SWITCH
SOFTWARE

7 MARCH 1977

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APPLICABLE DOCUMENTS

The following documentation was referenced during the preparation of this document.

25X1A

- RT-11 Description Documents (Top Level)
- [REDACTED] Digital Data Switch Specification
- [REDACTED] Imagery Transmission System Specification
- [REDACTED] ITS Remote Terminal Subsystem Specification
- [REDACTED] COMSEC Interface Conditioning Unit Specification
- [REDACTED] Central Site Interface Equipment Specification

Receiver Terminal States and Change Definitions

To simplify the Digital Data Switch software, each Receiver Terminal will be placed into one of five possible software states. On-hook terminals connected to the idle format will be placed in the B0 state from which all actions originate. Terminals going off-hook are placed in the B1 state until the completion of dial tone, ringback or transmission. Upon going on-hook, the terminal is again placed in the B0 or idle state. Associative parties called by a terminal in B1 are intermittently placed in the B2 state (ringing) until they go off-hook (B1) or the calling party goes on-hook (back to B0).

Three additional states (B3, B4, B5) occur as a result of the Broadcast capabilities of the switch. All parties on a Broadcast list, regardless of present state, are immediately placed in the temporary holding state of B3 to insure that no further transactions concerning a broadcast list party will take place until the Broadcast Initiator has attempted to make a connection. If an applicable broadcast list party was previously in the idle state (B0), the party is transferred to the ring state (B4) until that party goes off-hook (B5).

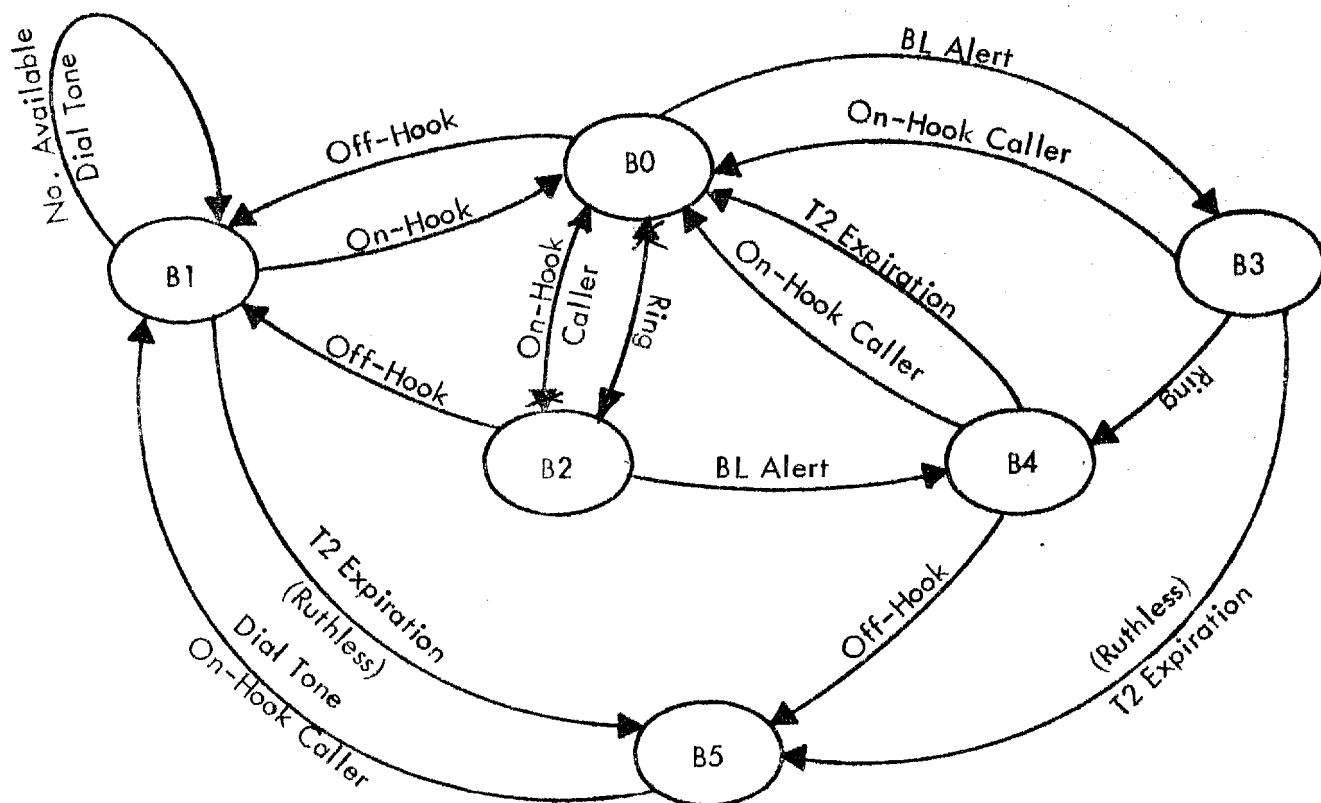
If the Broadcast list party was in the active B1 state, that state will not be interrupted until the party goes on-hook or the T2 timer expires. A party in the B2 state (ringing) is immediately associated with the Broadcast Initiator as the party ringing the terminal and transferred to B4.

Additional state transfers that are possible are illustrated in Figure 1 State Change Diagram. State changes can be forced by the expiration of T2 timer or by an associative calling party going on-hook (on-hook caller).

Example: If party A initiates a call to party B but goes on-hook while B is ringing, party B will return to the B0 state via the on-hook caller

STATES FOR RT's

- B0 = Idle Format Connect
- B1 = Active Busy Duplex (requires RT action to go to B0)
or in Dial Tone State
- B2 = Awaiting Action Busy (Ringing)
- B3 = Broadcast List Party Awaiting Prior Activity Cessation or Timer Expiration
(this state may be simultaneous with B1)
- B4 = Broadcast Awaiting Action Busy (Ringing)
- B5 = Broadcast List Party Off Hook Awaiting Broadcast Active or Is Active



State Change Diagram

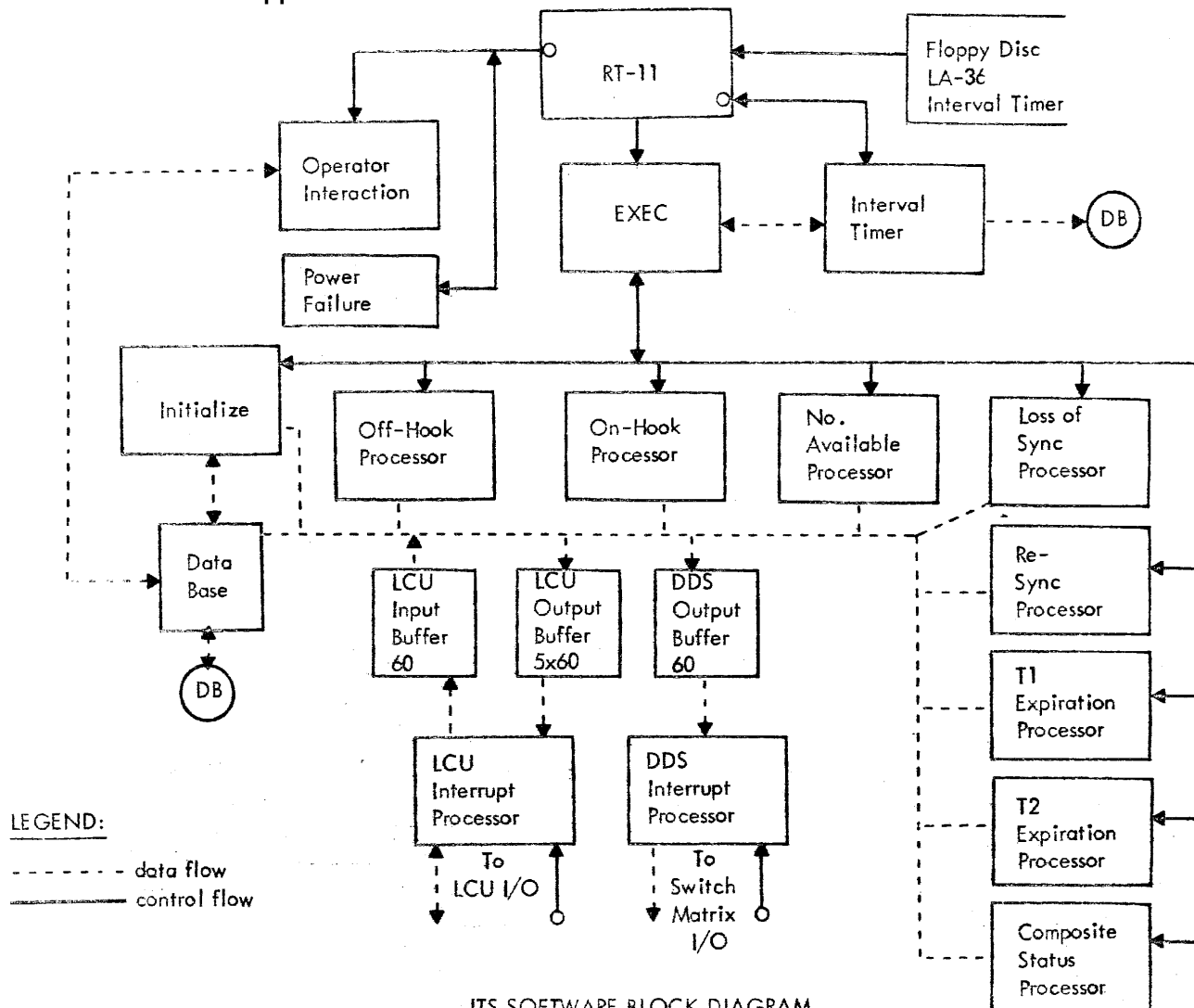
Figure 1

ITS SOFTWARE PHILOSOPHY

The Digital Data Switch software consists of a simple set of individual software modules designed to support a top down structured approach. The major modules of the DDS Software are shown in Figure 2 - ITS Software Block Diagram. Digital Equipment Corporation's off-the-shelf operating system - RT-11 - has been selected for use in the Digital Data Switch processor - PDP 11/04. RT-11 was selected because of its proven reliability, low overhead requirements, and efficient use of core.

Upon completion of system initialization, the Executive routine scans various buffers and flags, and turns on the appropriate processing module to handle a specific task. The input and output modules used for processing data to and from the LCU's and the Switch Matrix operate independently and asynchronously. This approach of separating the interrupt driven input/output processing from the internal data processing, allows the software to synchronize its input and output requirements with the 19 m sec frame time. Regardless of the loading requirements placed on the internal processing modules, terminal status input, composite status output, and switch matrix commands will be processed within the 19 m sec frame time envelope.

Parallel processing prevents a sudden batch of internal processing requirements from delaying the output of LCU tones and DDS switch commands generated by internal processors.



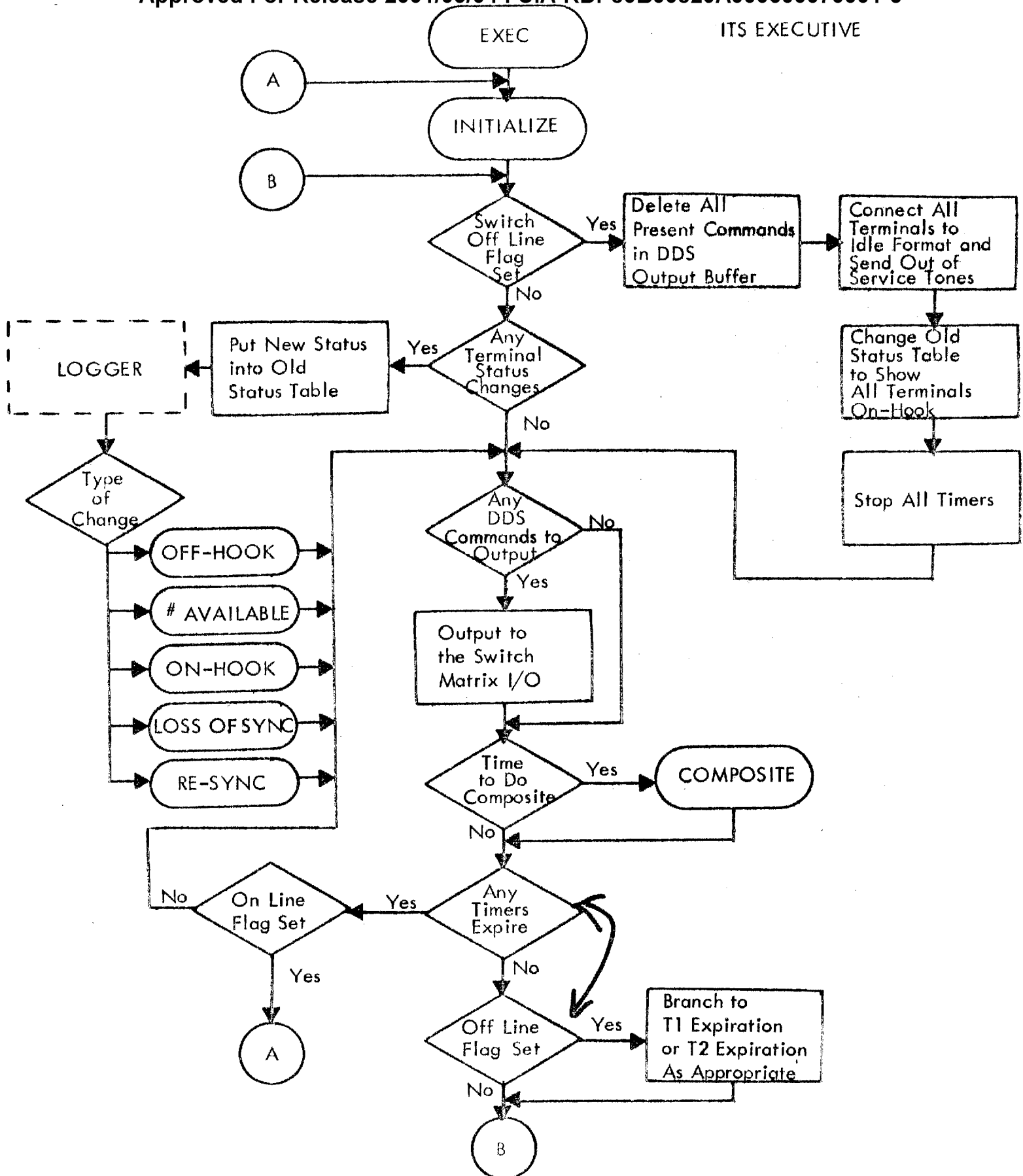
EXECUTIVE MODULE

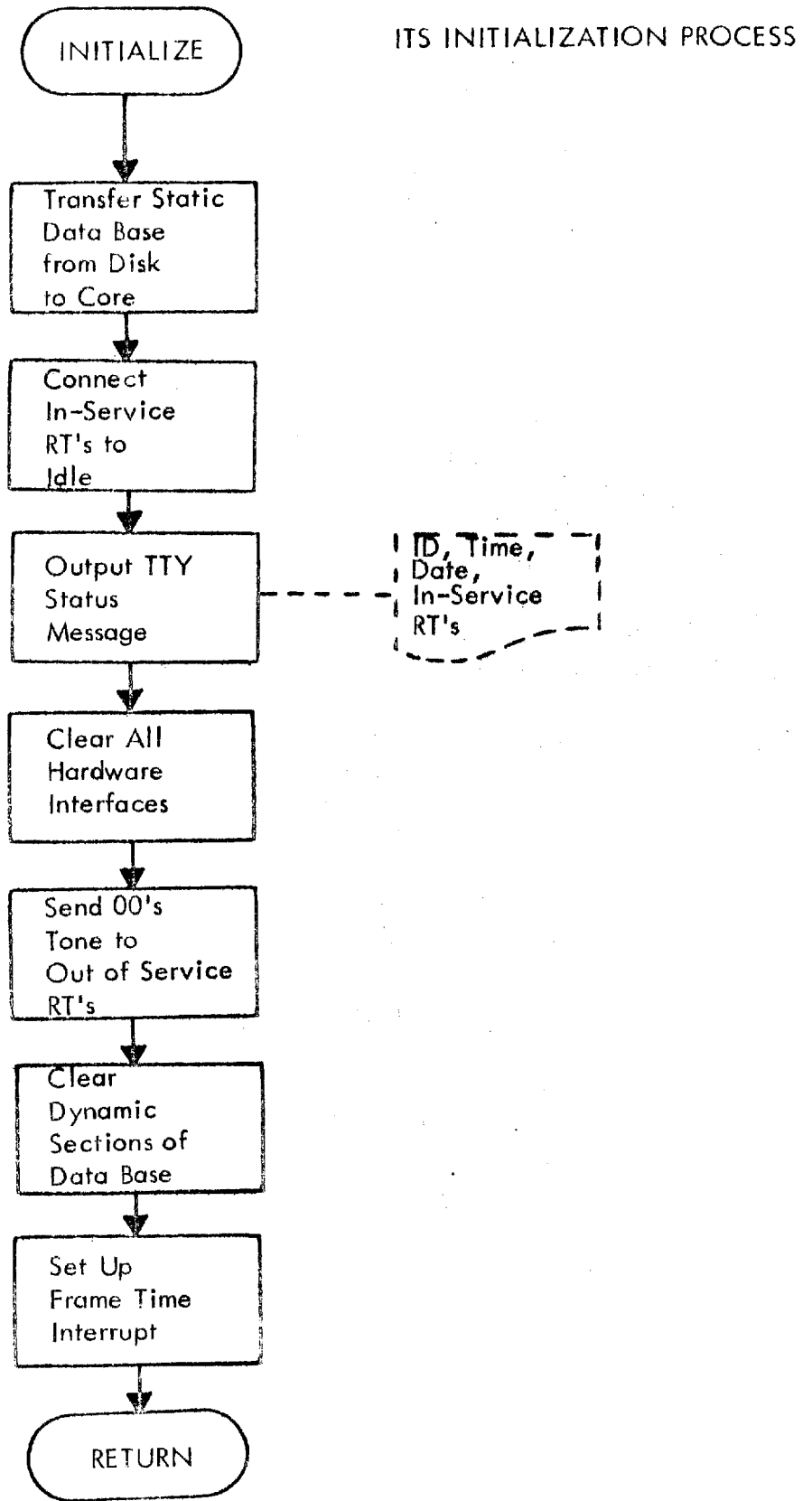
The Executive module receives control from the vendor's operating system upon completion of program loading from a floppy disc. The executive routine first initializes the software and hardware via the Initialize routine. During initialization, the frame time interrupt is enabled, thus permitting the interrupt level I/O routines to open communication channels for terminal switching requests.

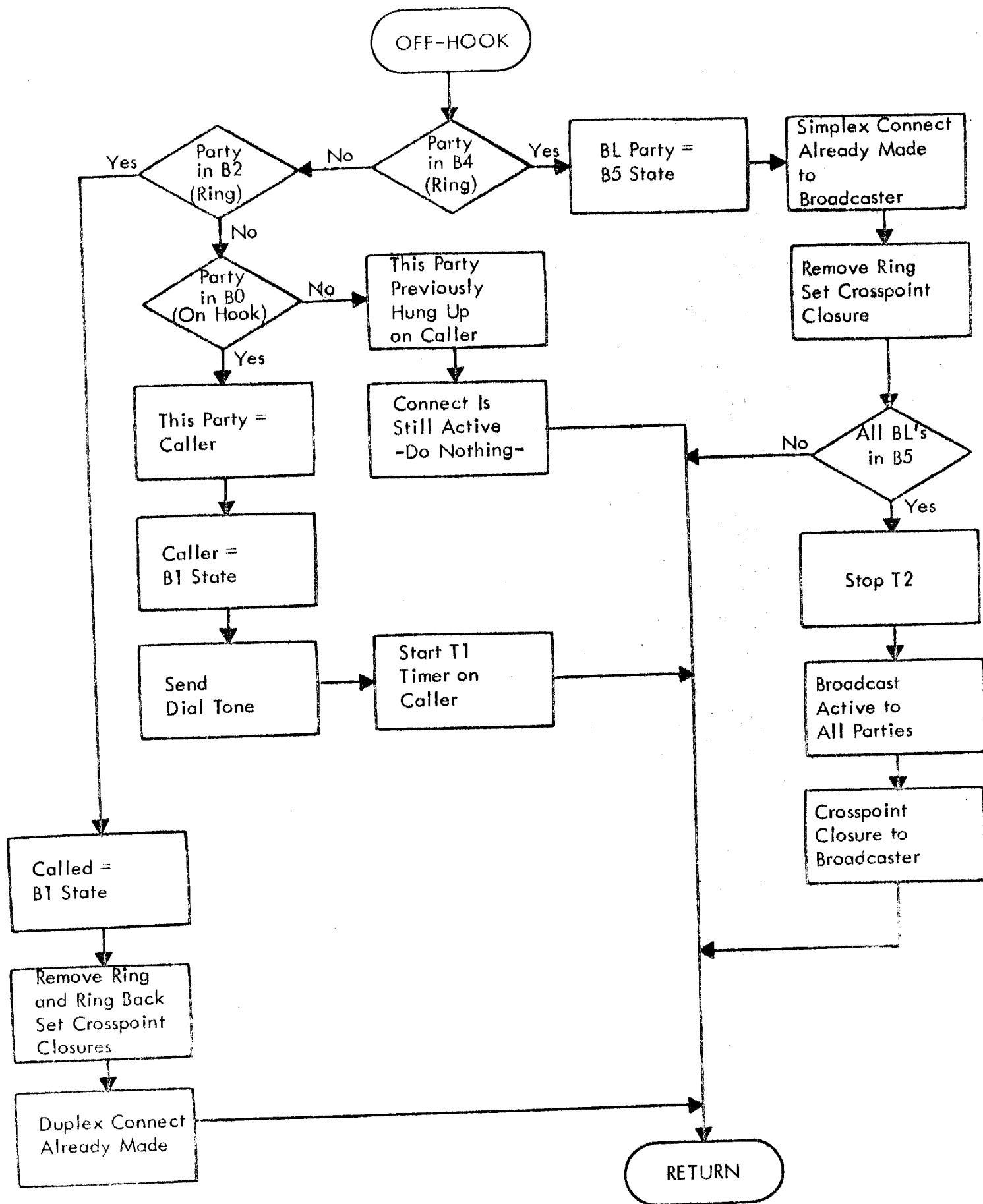
The executive scans various buffers and flags and passes control to the appropriate processing routines. The executive maintains a table of terminal status values that are compared with present values during each frame time. The five variables in the status that can alter state following terminal activity are:

- Off-hooks
- On-hooks
- Number available
- Loss of sync
- Re-sync

ITS EXECUTIVE

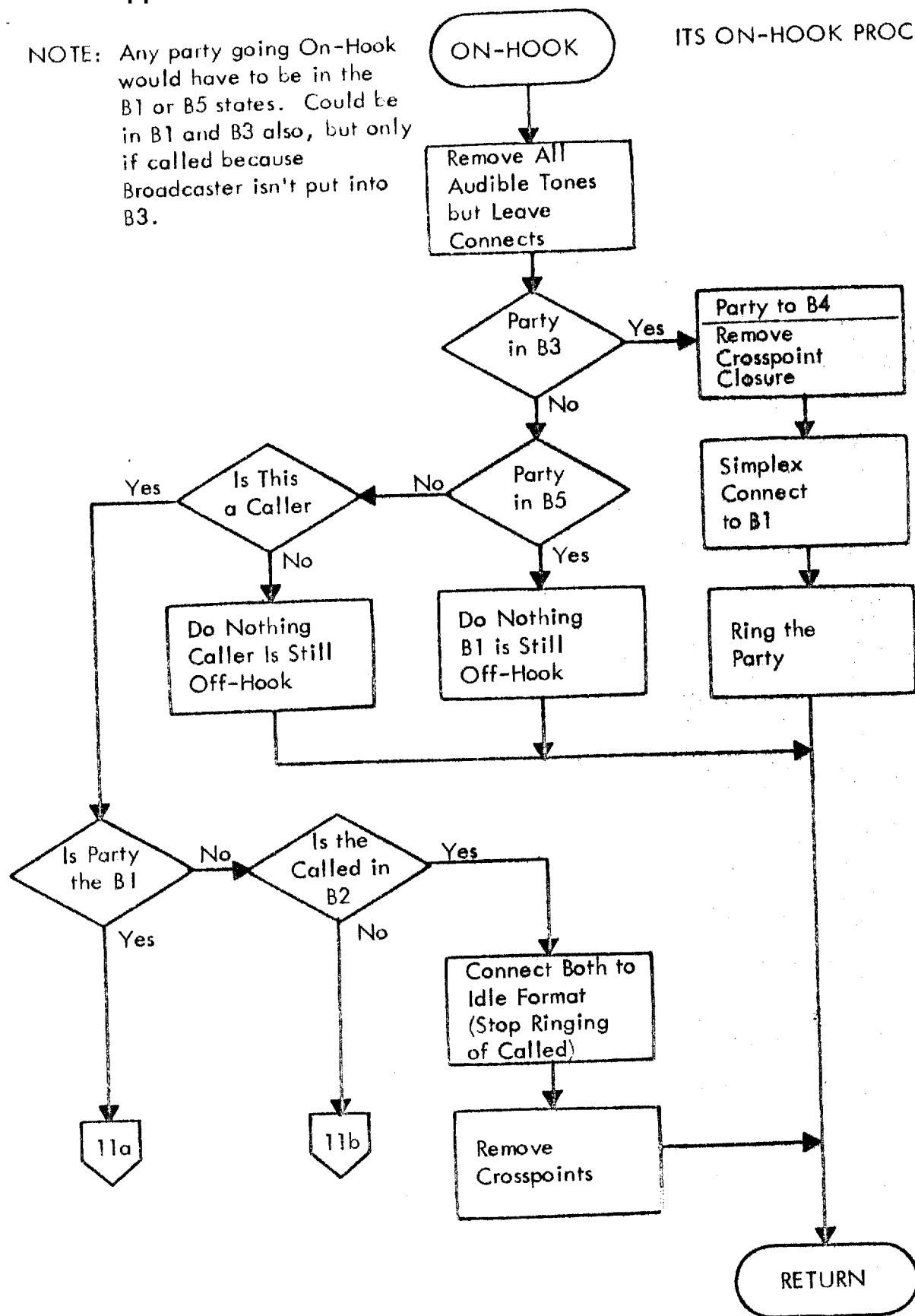


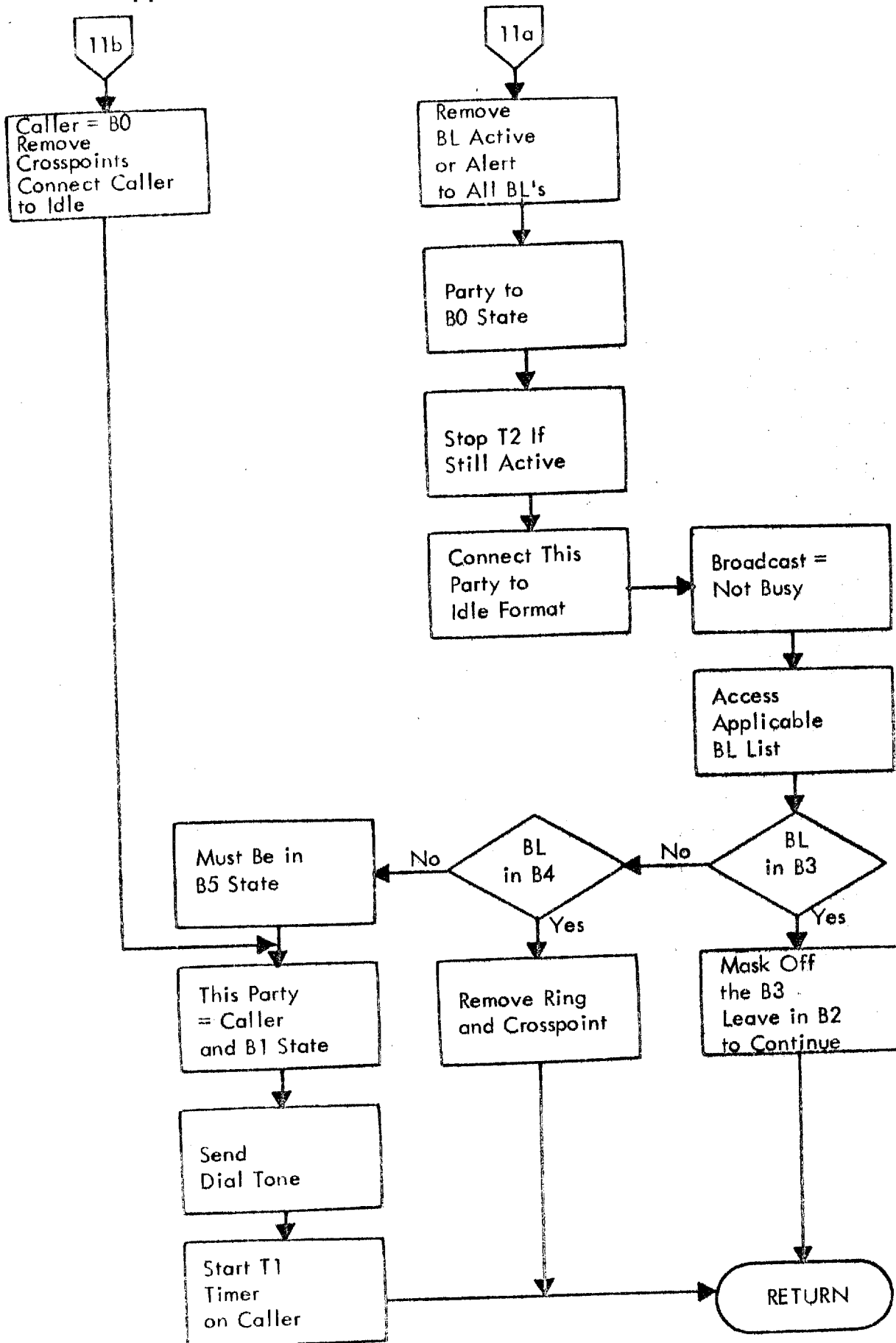


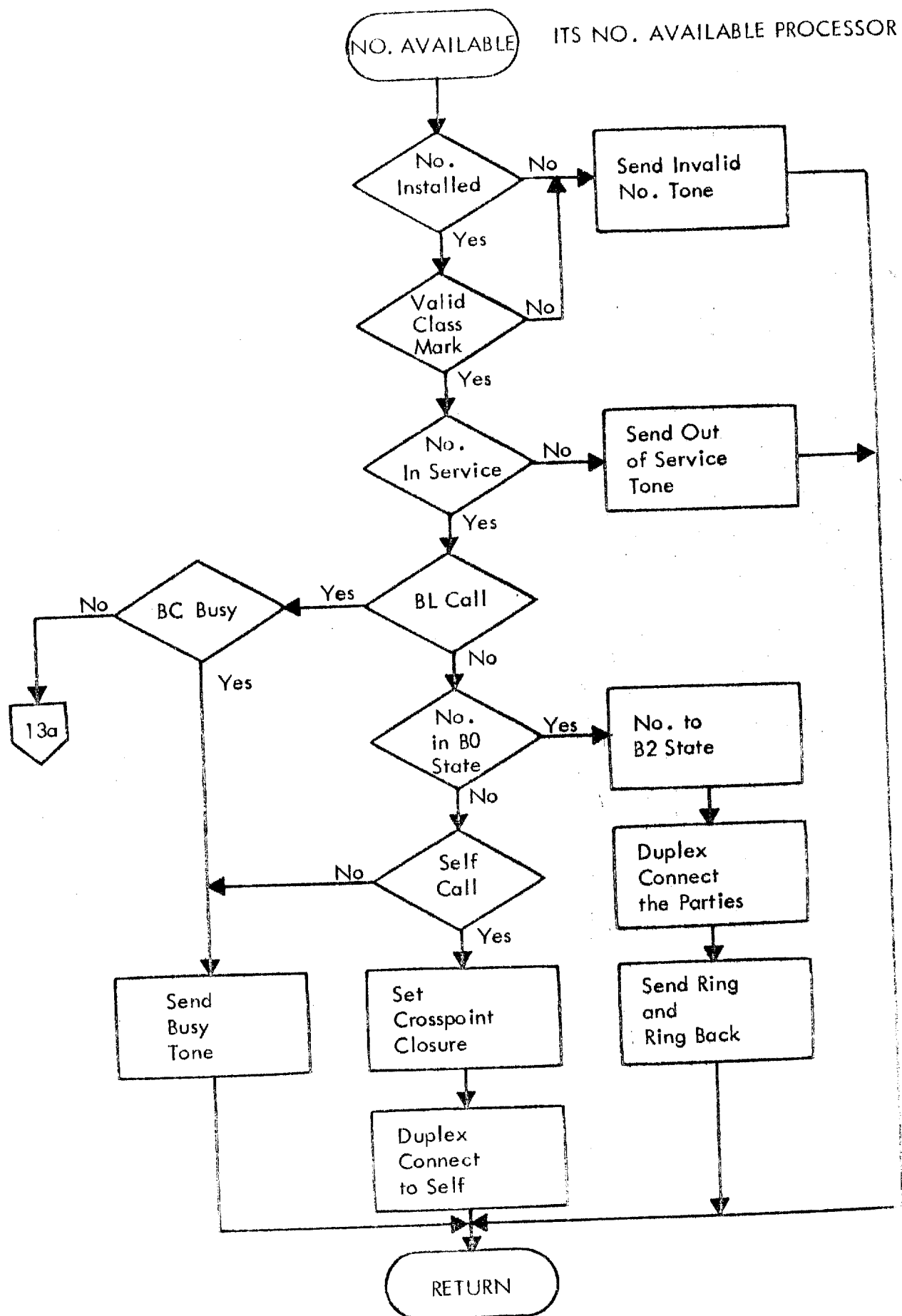


NOTE: Any party going On-Hook would have to be in the B1 or B5 states. Could be in B1 and B3 also, but only if called because Broadcaster isn't put into B3.

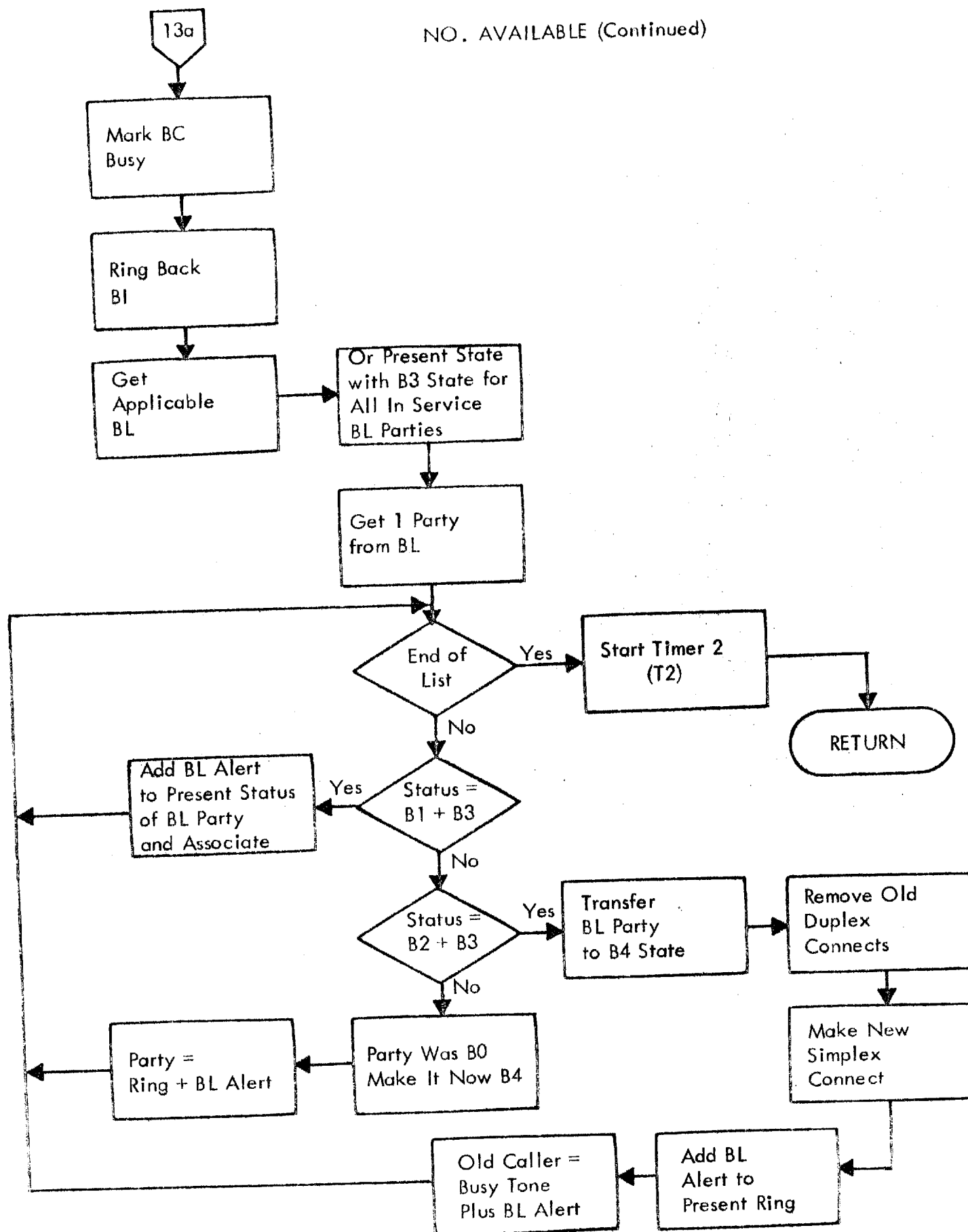
ITS ON-HOOK PROCESSOR



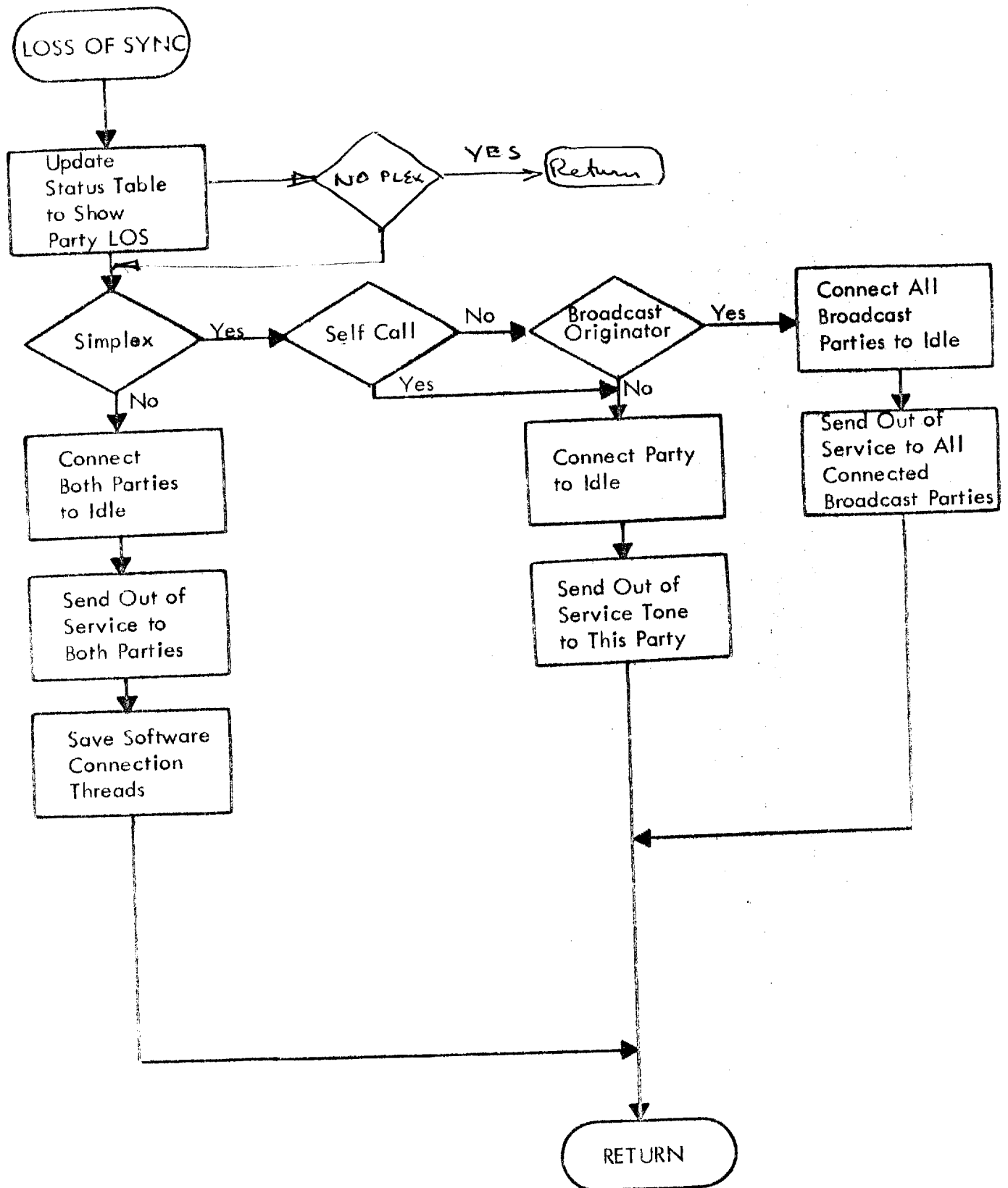




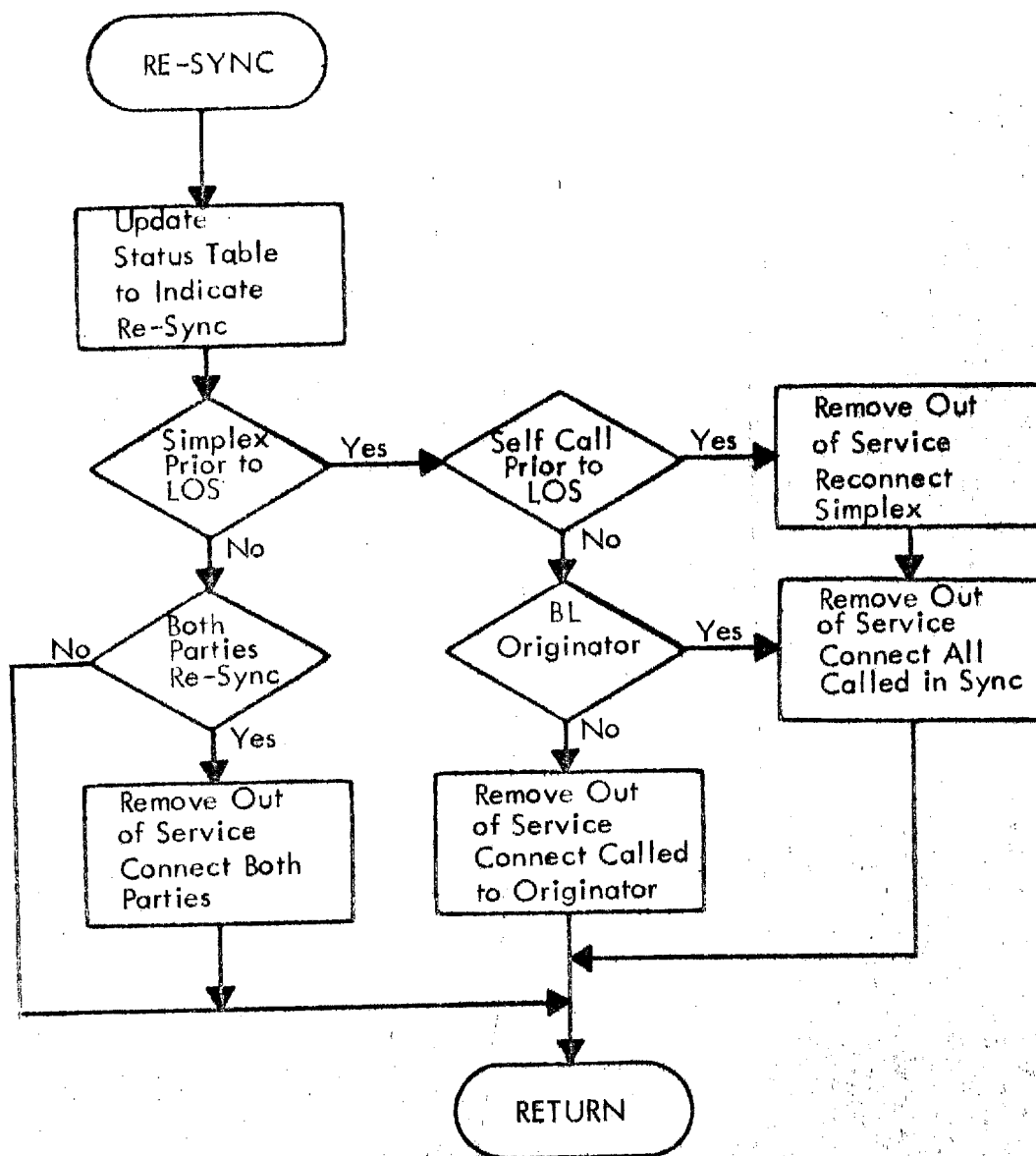
NO. AVAILABLE (Continued)

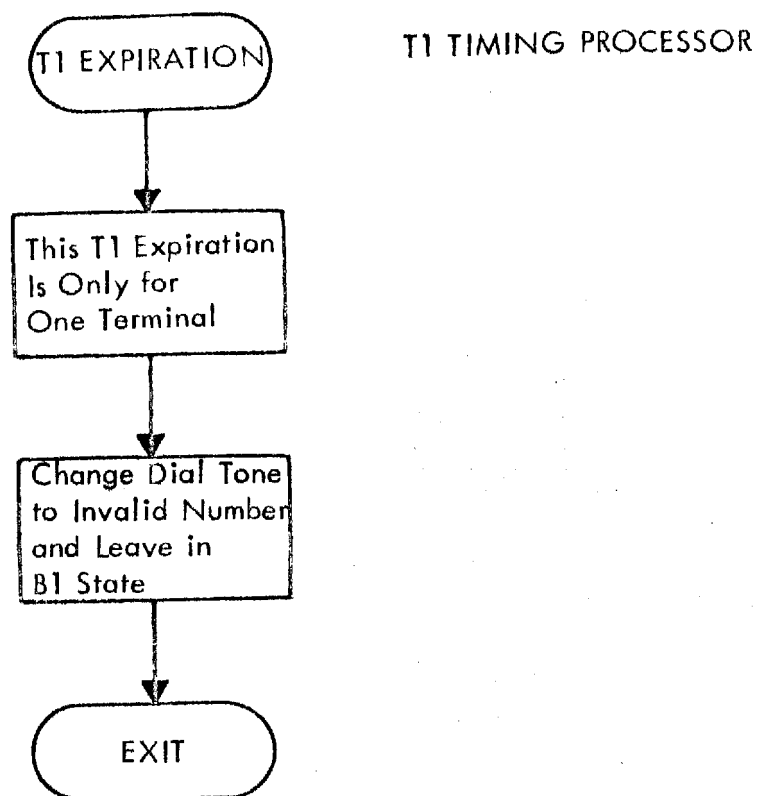


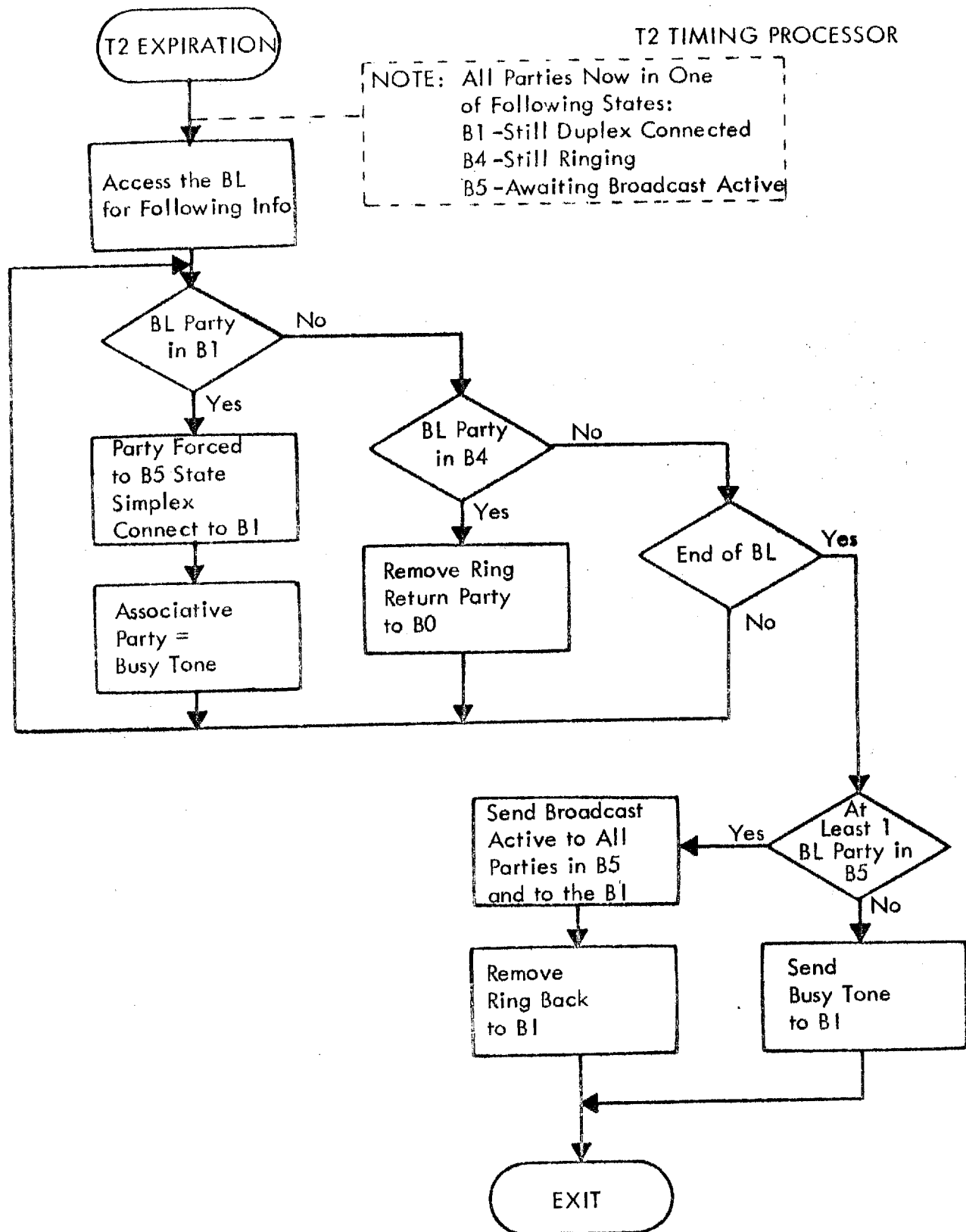
ITS LOSS OF SYNC PROCESSOR

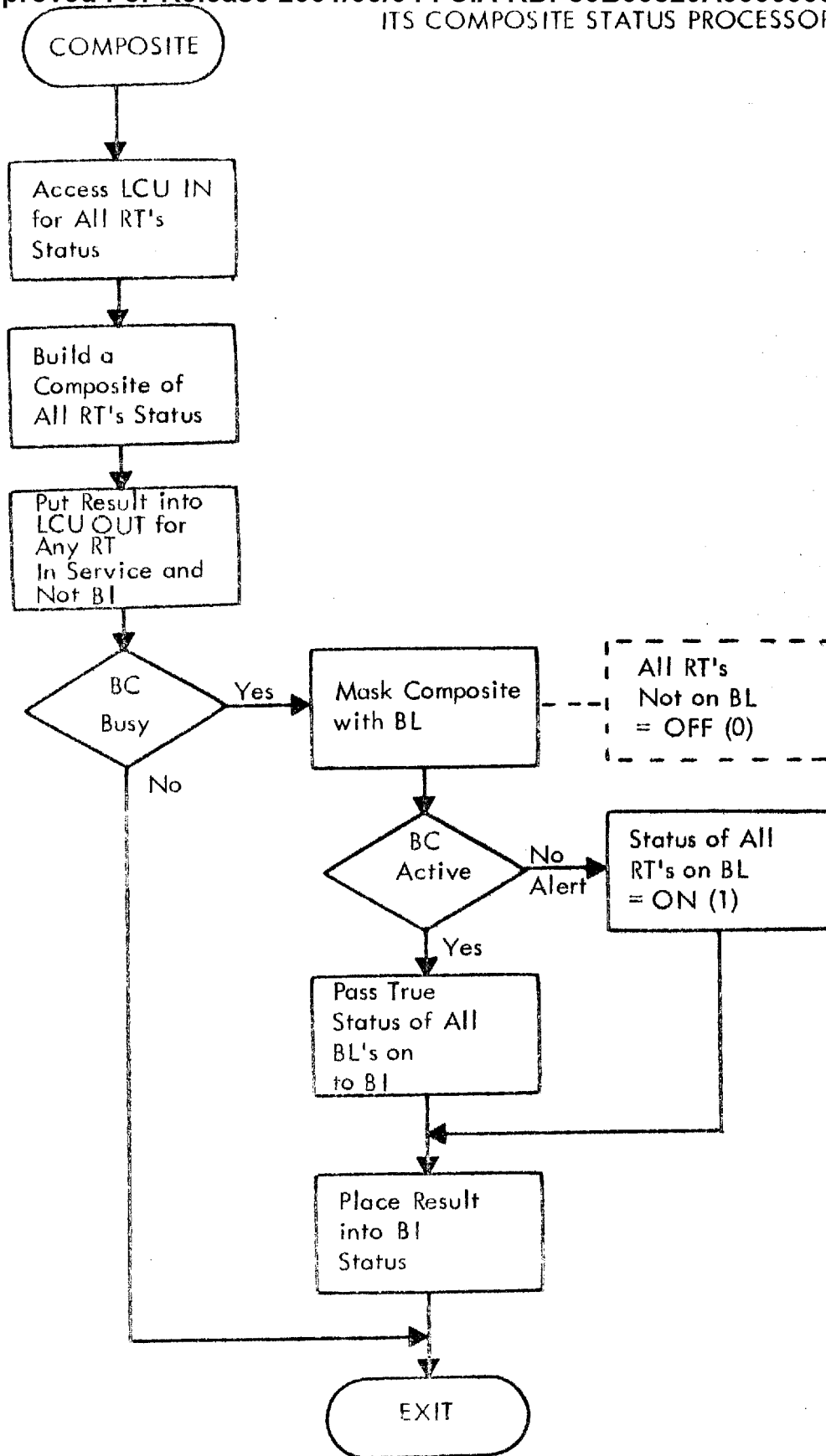


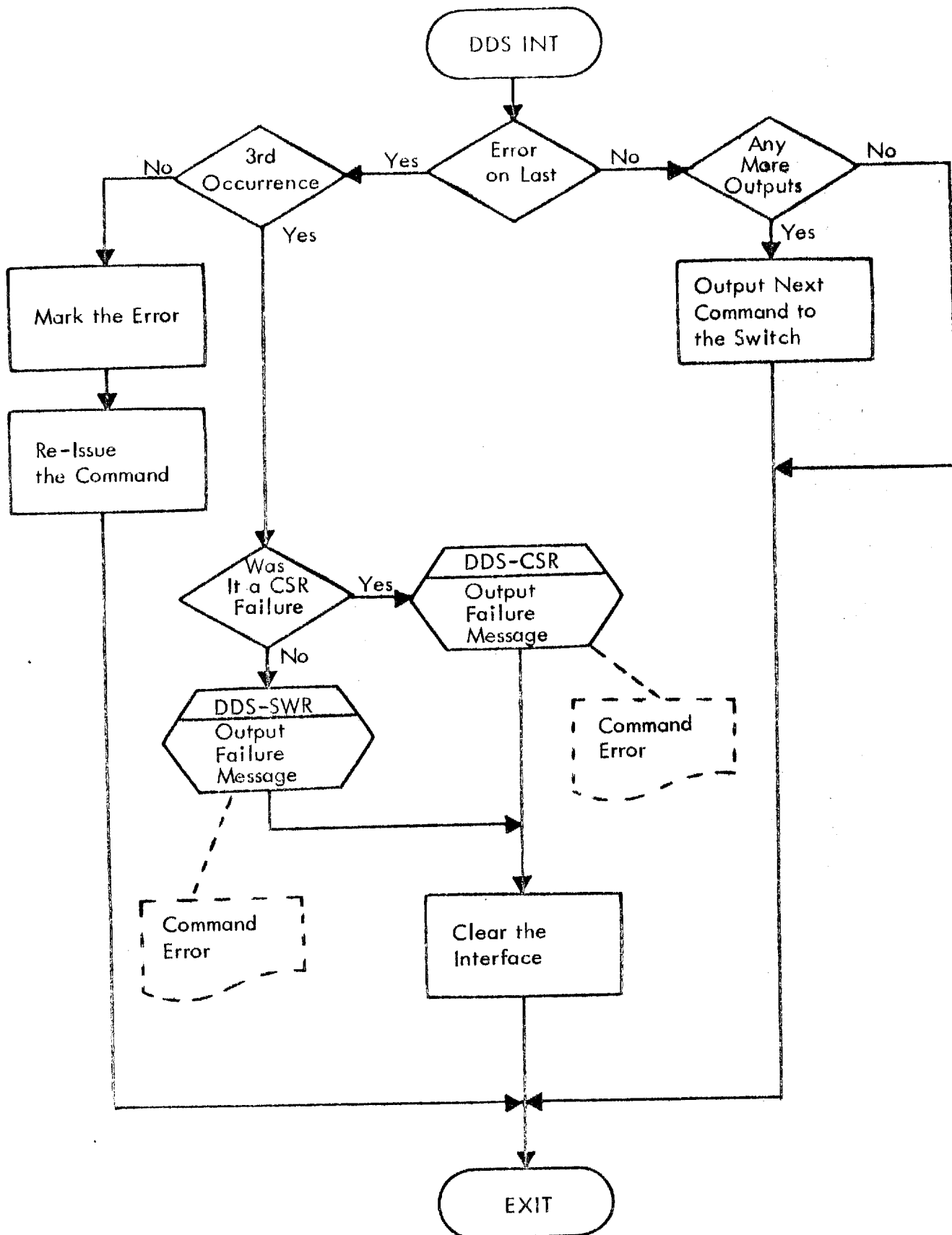
ITS RE-SYNC PROCESSOR

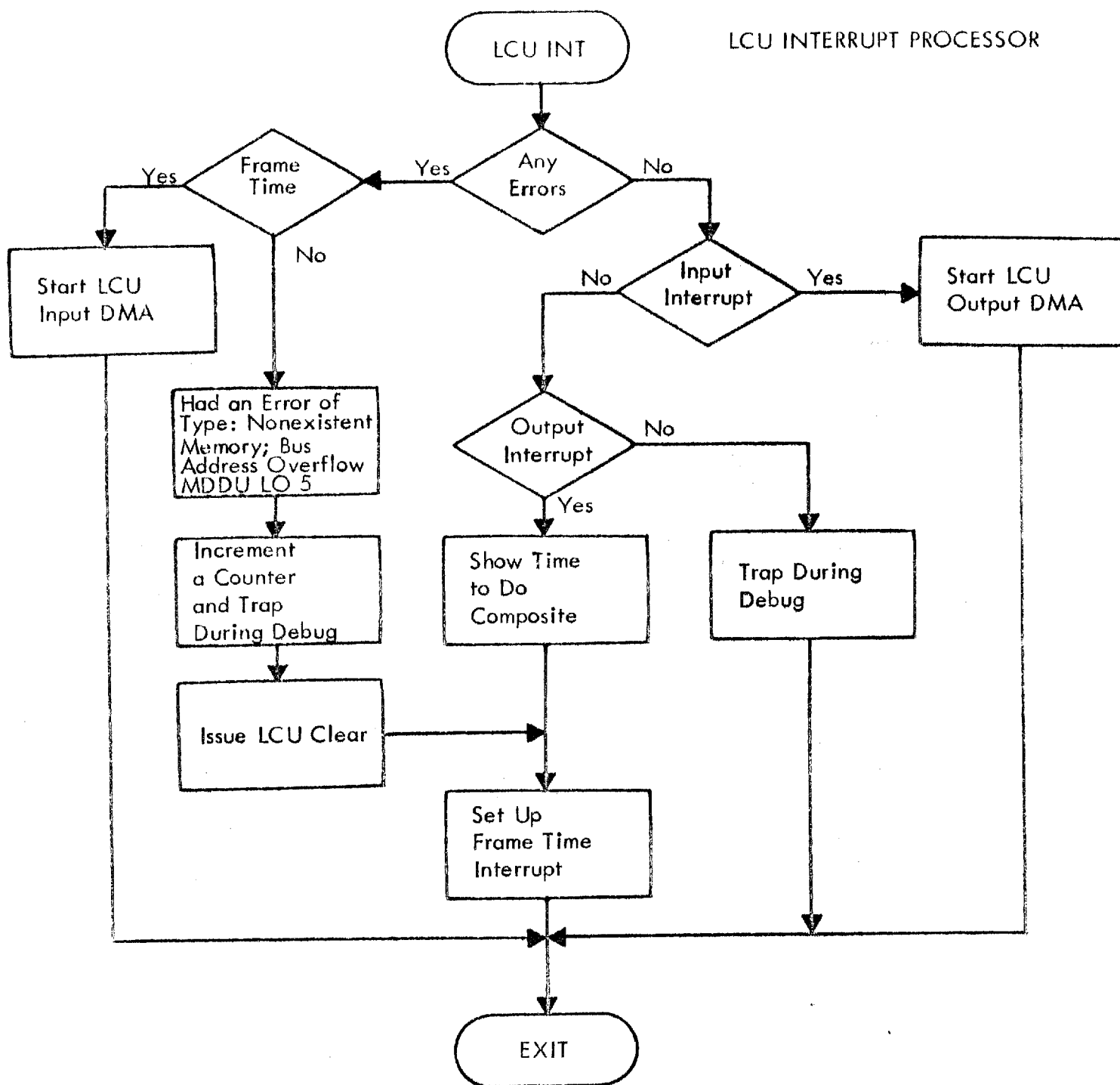


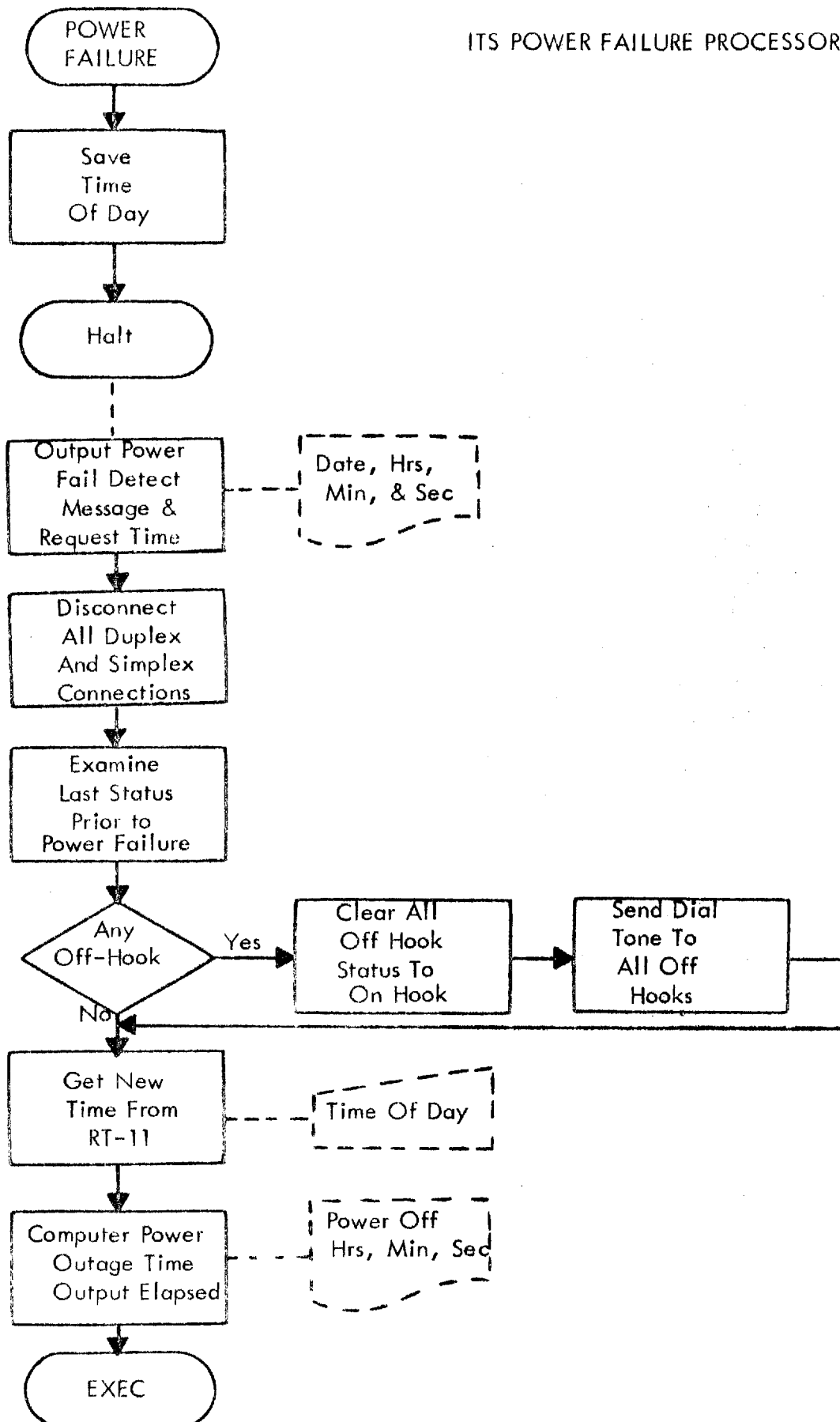




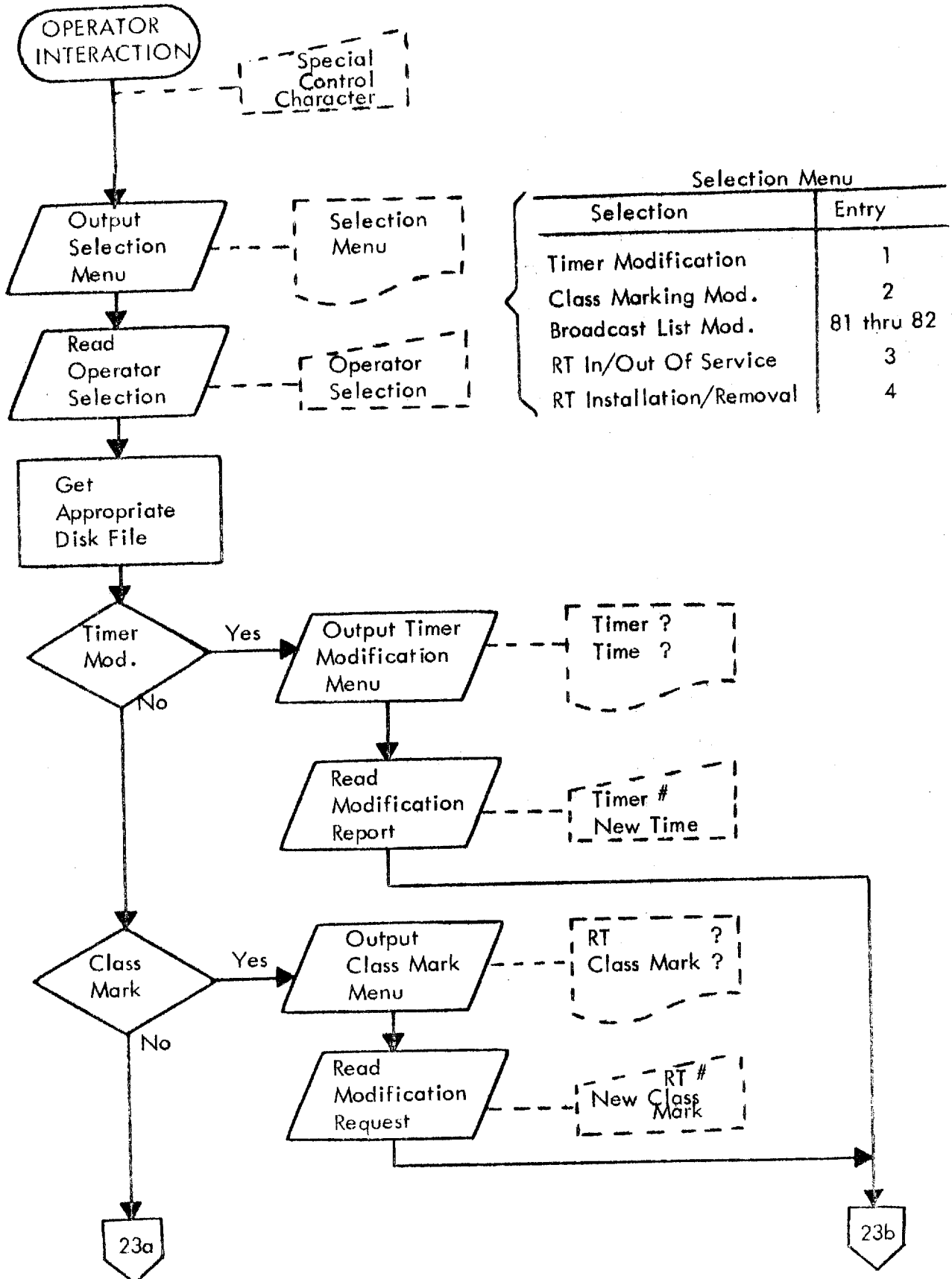


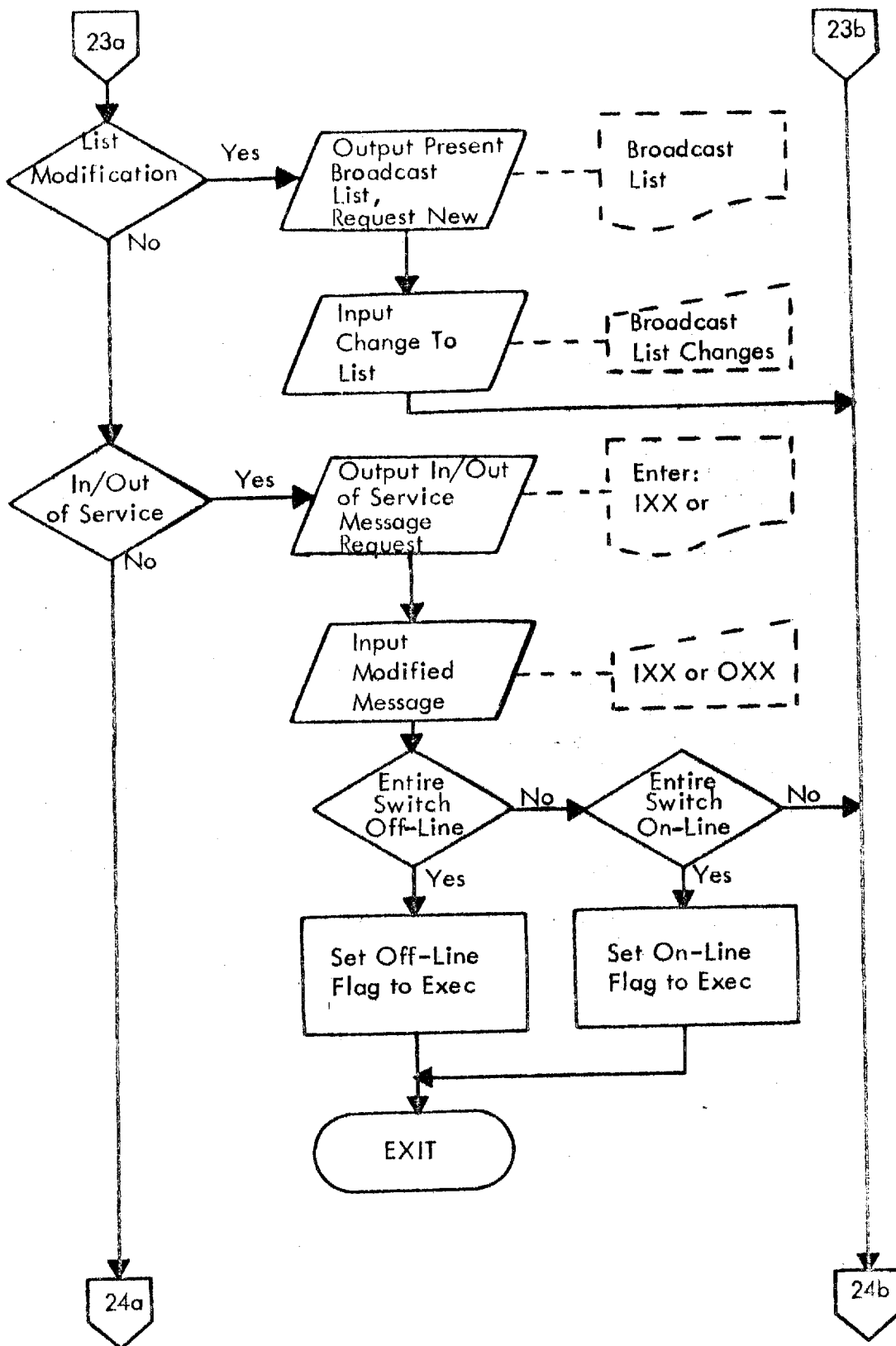


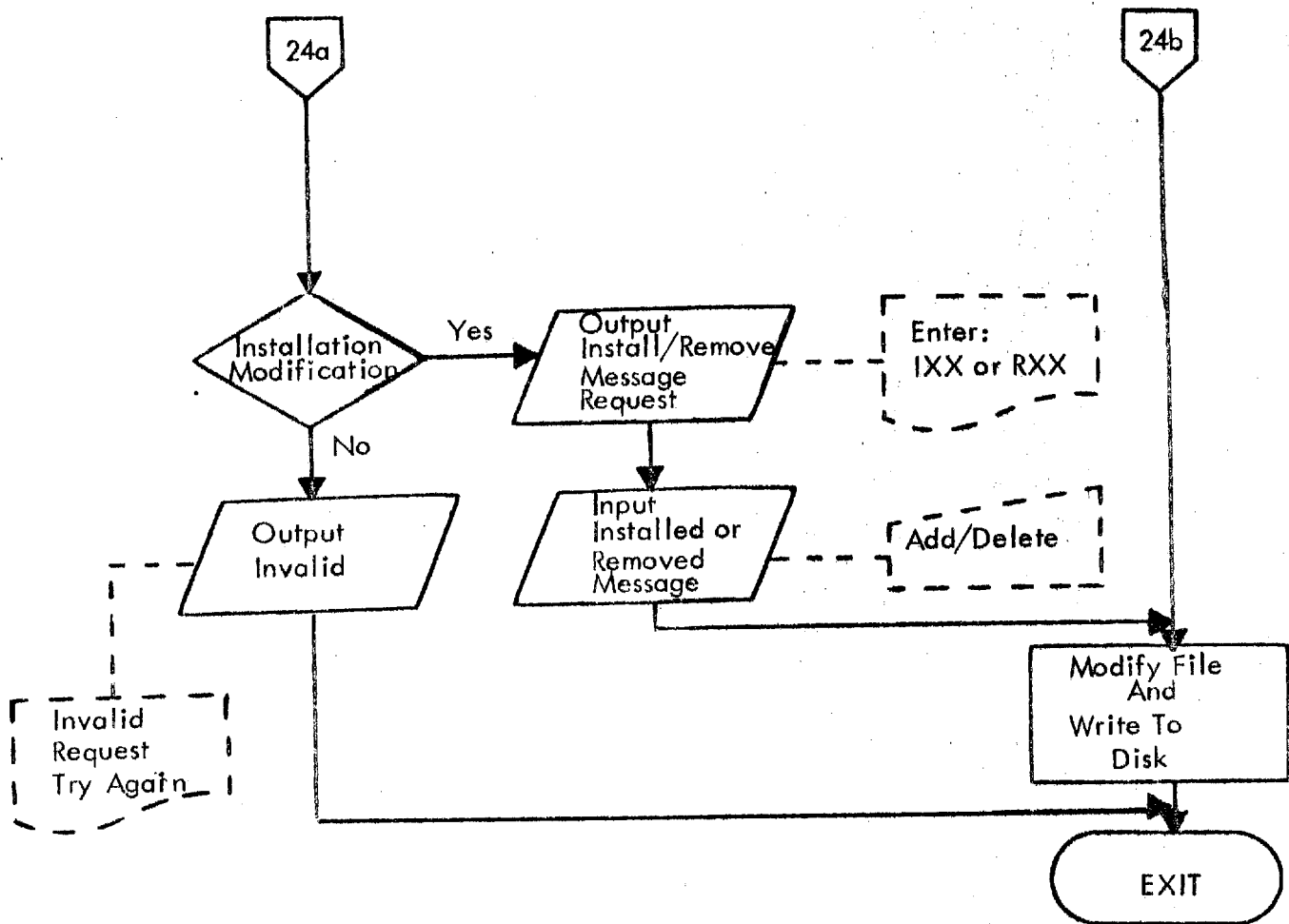




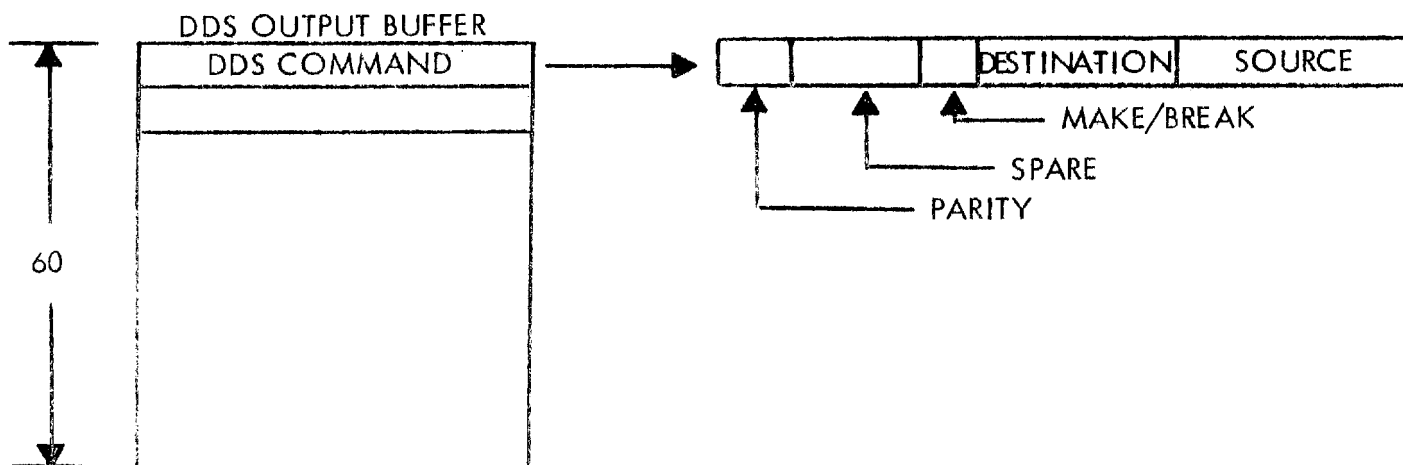
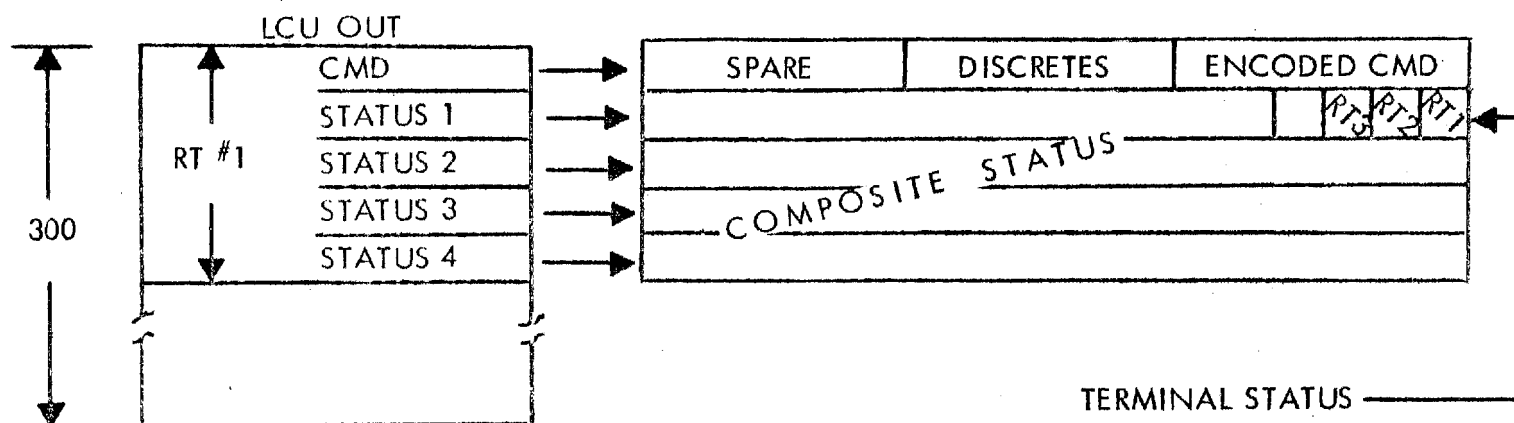
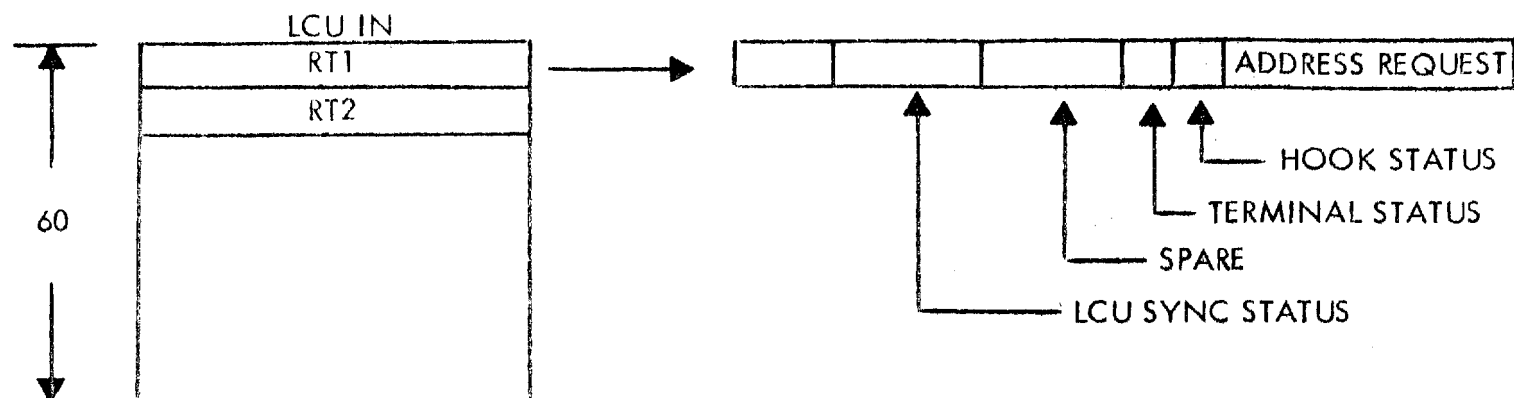
ITS OPERATOR INTERACTION



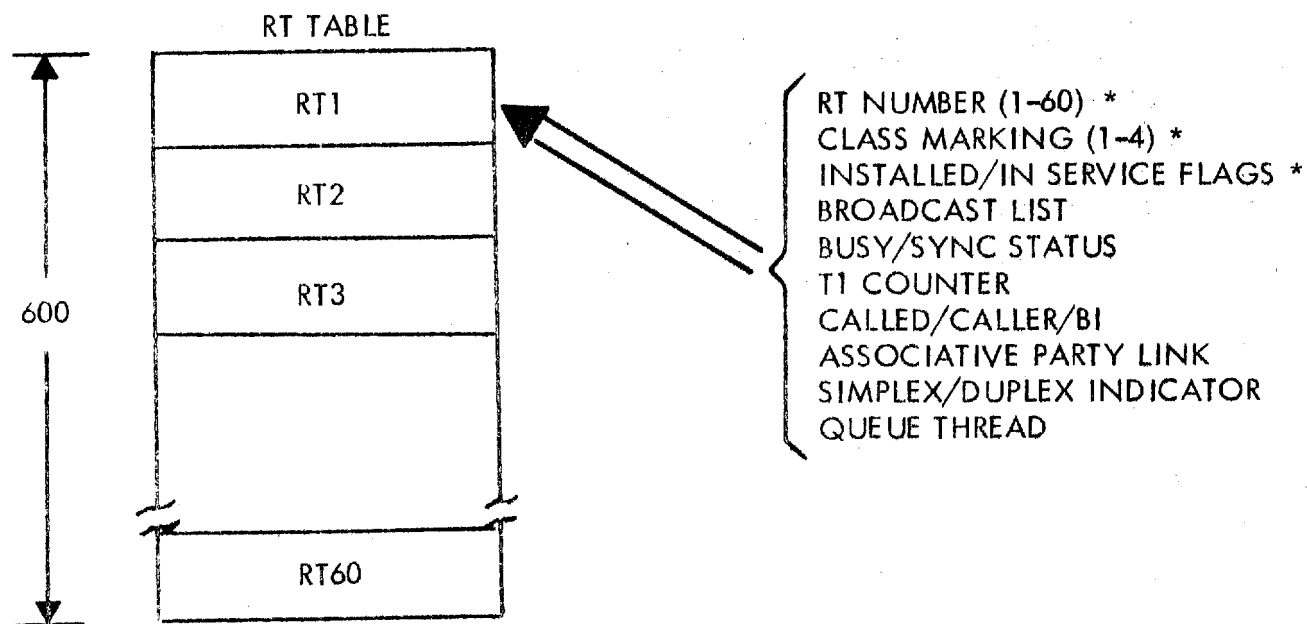




ITS TABLES



ITS DATA BASE



* = STATIC PORTION OF DATA BASE

| TIMERS | |
|--------|-------|
| T1 | TIMER |
| T2 | TIMER |

TIMER RESET VALUES *

ITS Software Timing Analysis

CPU Loading Calculations:

| Processing Time for Activities (msec) | <u>STATIC</u> | <u>DYNAMIC</u> |
|---------------------------------------|---------------|----------------|
| ● Set Up for Frame Interrupt | .1 | |
| ● Set Up for LCU Inputs | .1 | |
| ● Set Up for LCU Outputs | .1 | |
| ● Set Up for DDS Output | .1 | |
| ● Seek New Task (Change of State) | 2 | |
| ● Process On-Hook | | 1 |
| ● Process Off-Hook | | .8 |
| ● Process No. Available | | 2 |
| ● Process Composite Status | 2 | |
| ● General Overhead | 2 | |
| TOTAL DMA CYCLE STEALING (60 x 6) | .4 | |

Summaries

| | |
|--------------------------------------|-------------------|
| Processing with No Activity (Static) | = 4.8 msec |
| CPU Loading (Static) | = 25% |
| 1 Single Task (No. Available) | = 4.8 + 2 = 6.8 |
| CPU Loading (Single Task) | = 36% |
| Heavy Loading (5 of Each Process) | = 4.8 + 19 = 23.8 |
| CPU Load (Overload) | = 125% |

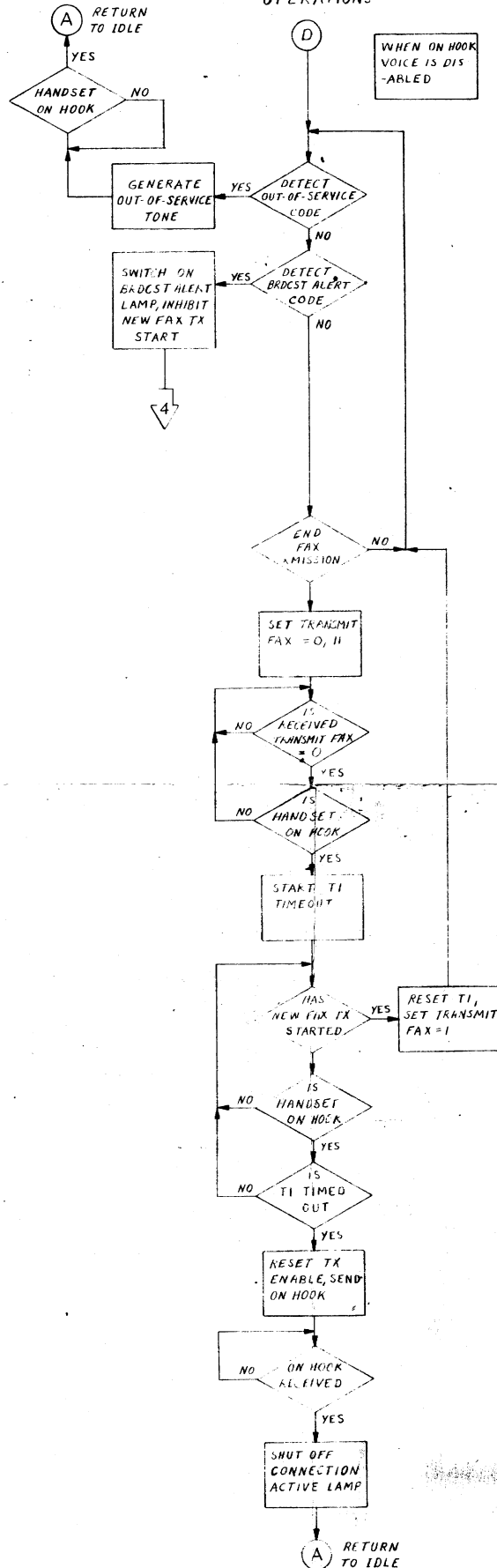
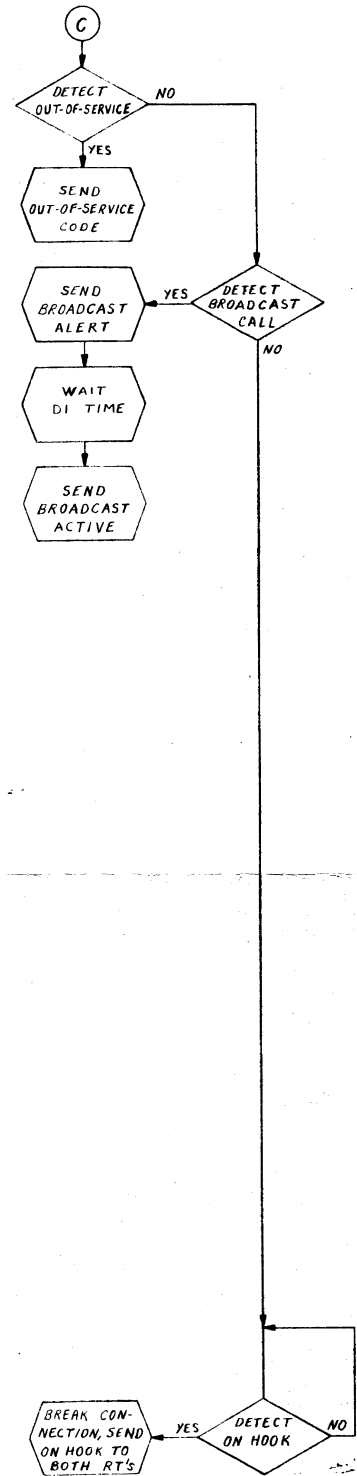
USER
OPERATIONS

THE USER
MAY AT HIS
OPTION GO ON
HOOK

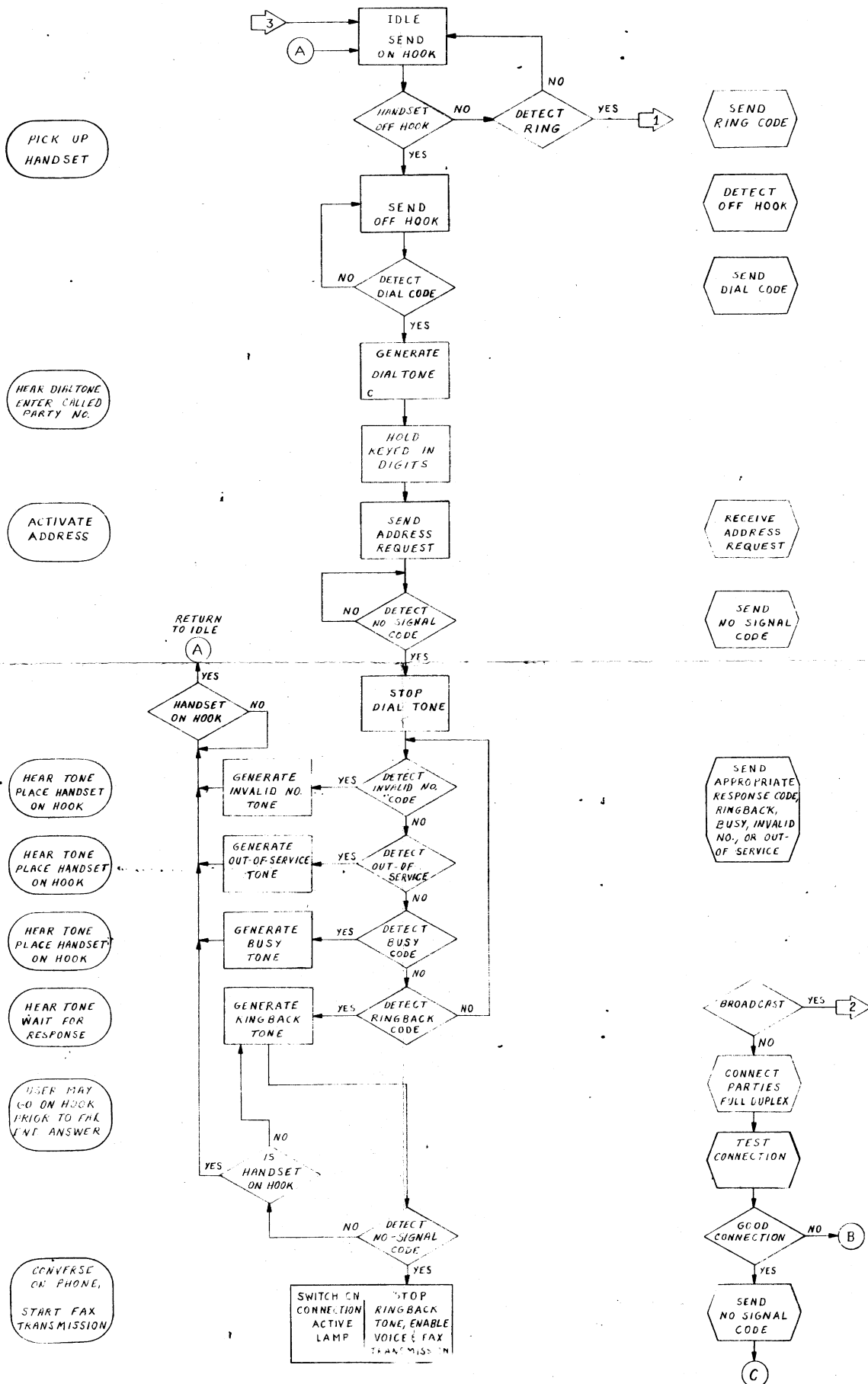
HEAR TONE
PLACE HANDSET
ON HOOK

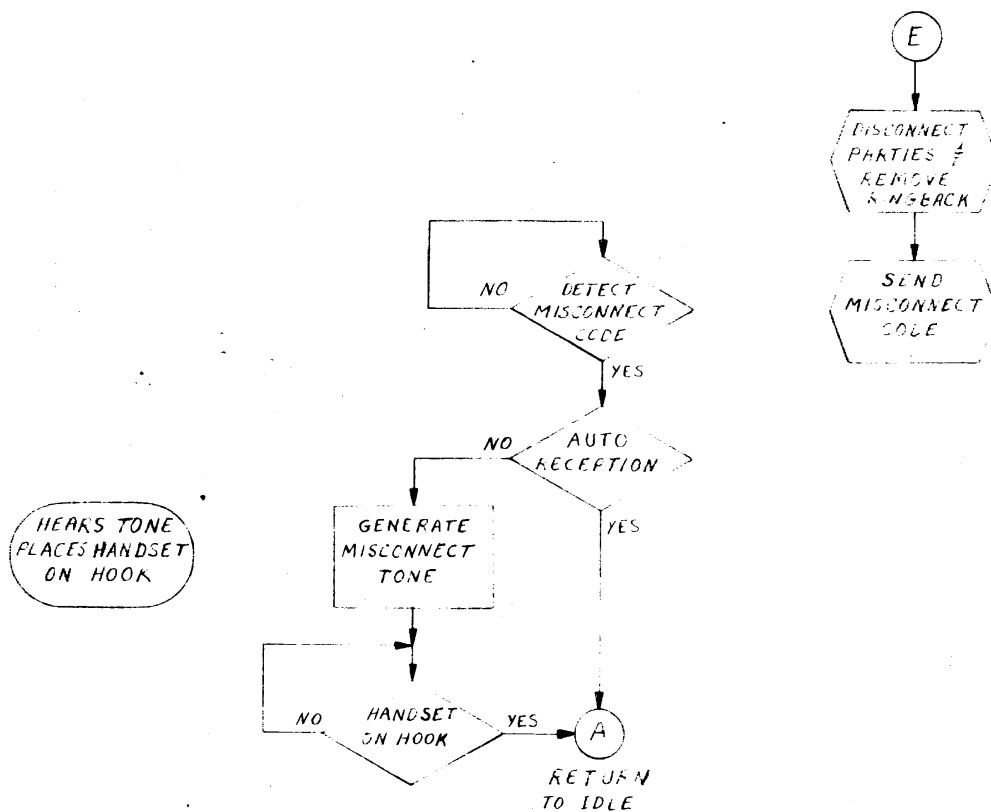
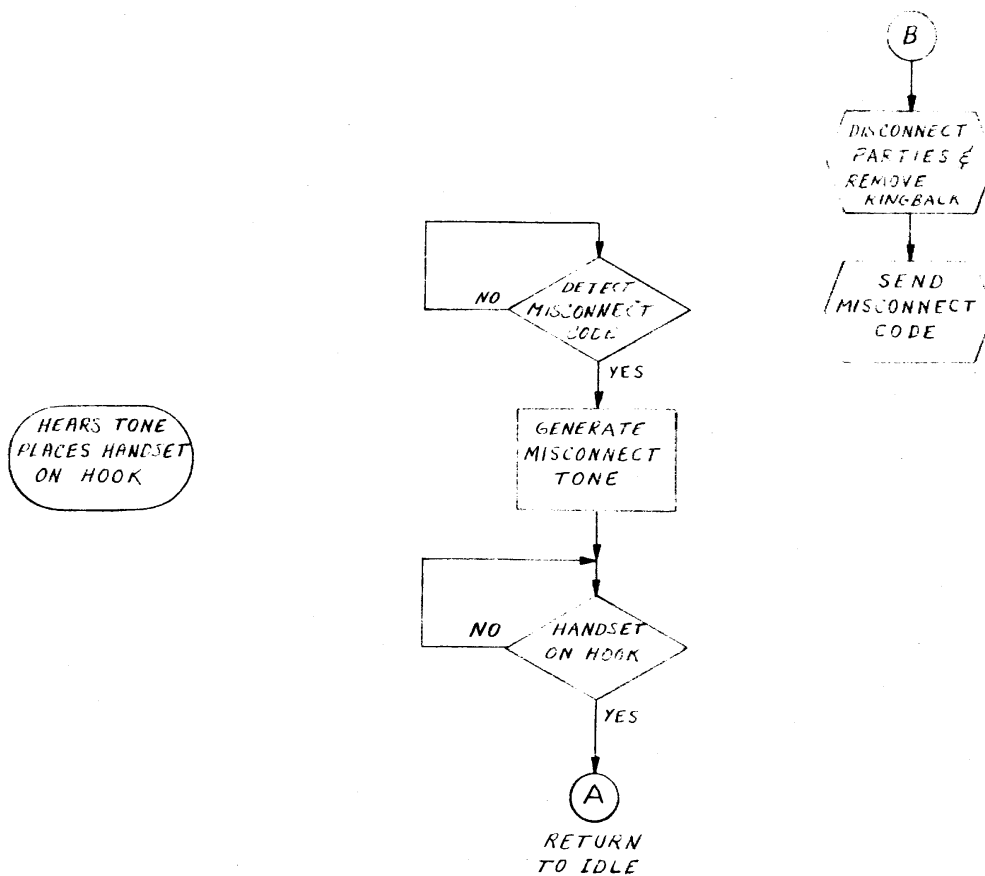
SEE LAMP
CONCLUDE
DISCUSSION &
FAX TX

USER NOTES
END OF TX, MAY
GO ON HOOK OR
START NEW FAX
TRANSMISSION

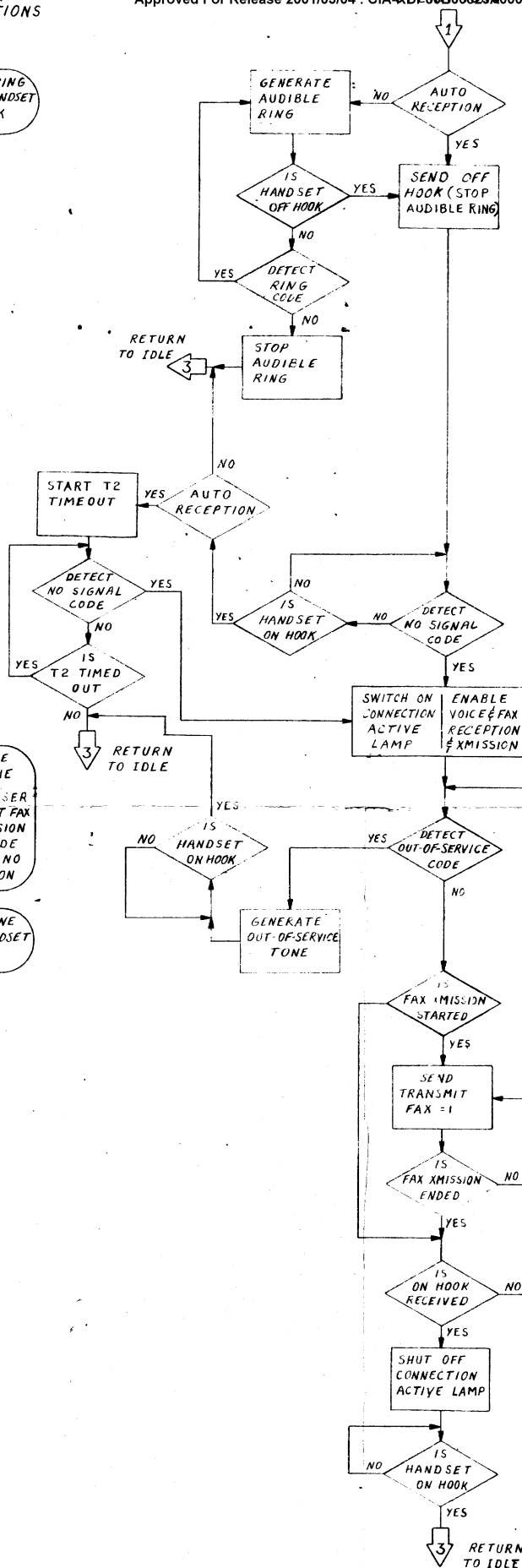
REMOTE TERMINAL
OPERATIONSSWITCH
OPERATIONSFLOW DIAGRAM II
CALLING TERMINAL SEQUENCE

Sheet 2 of 2

USER
OPERATIONSREMOTE TERMINAL
OPERATIONSSWITCH
OPERATIONSFLOW DIAGRAM II
CALLING TERMINAL SEQUENCE

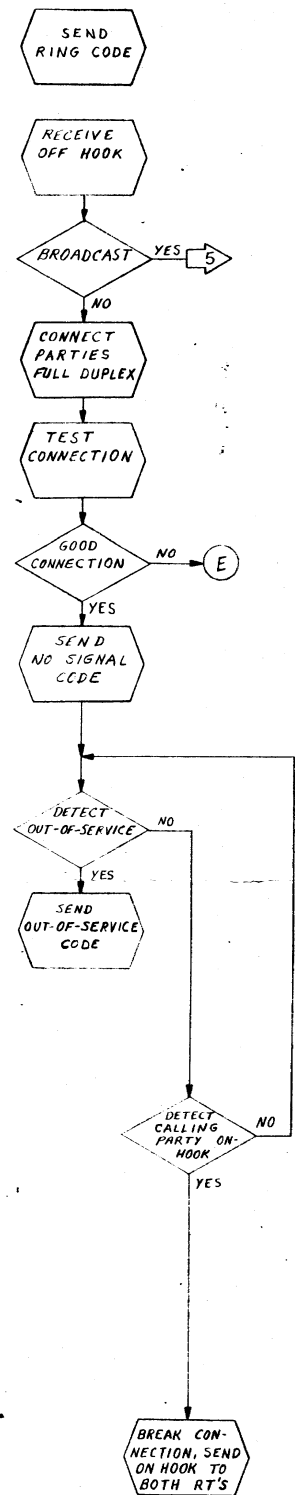


HEARS RING
TAKES HANDSET
OFF HOOK



CONVERSE ON PHONE
CALLED USER
MAY START FAX
TRANSMISSION
AUTO MCDE
REQUIRES NO
USER ACTION

HEARS TONE
PLACES HANDSET
ON HOOK



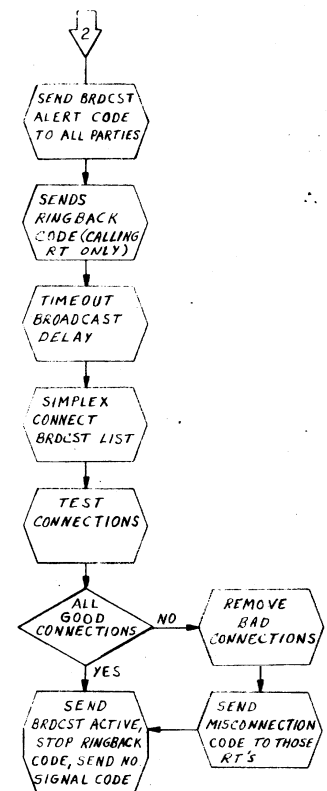
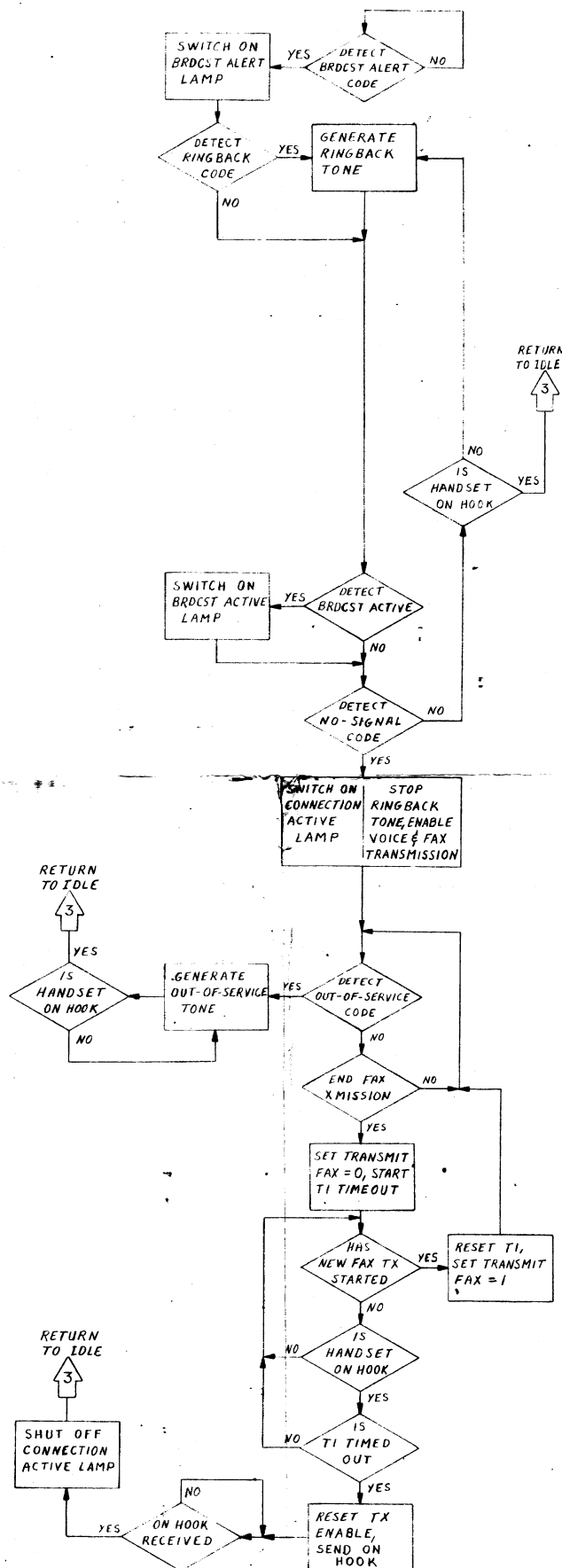
FLOW DIAGRAM III
CALLED TERMINAL SEQUENCE

USER SEES
BROADCAST ALERT
INDICATION

SPEAK ONLY
ON PHONE,
START FAX
TRANSMISSION

THE USER
MAY AT HIS
OPTION GO ON
HOOK

HEARS TONE
PLACES HANDSET
ON HOOK



FLOW DIAGRAM IV
CALLING BROADCAST SEQUENCE